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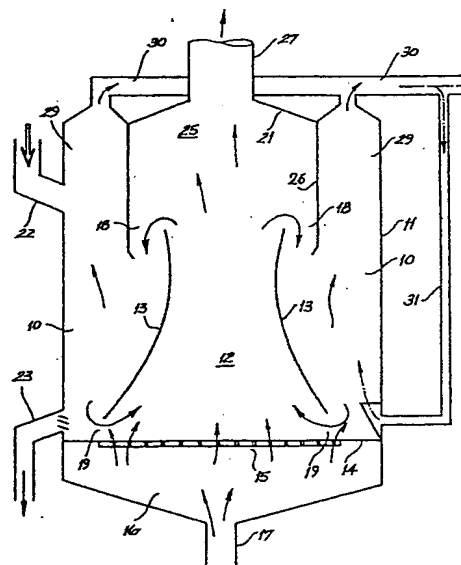
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54 **Method of and apparatus for contacting fluids and particulate materials.**

57 A method of and apparatus for the pyrolysis of particulate material by a continuous process using heat medium particles in a combustion chamber (12) and a pyrolysis chamber (10) arranged side-by-side and connected by an upper interconnection passageway (18) extending between the chambers, and a return passageway (19). The particulate material is fluidized in the chambers and induced to circulate therebetween by the configuration of the chambers and passageways and/or the nature of the fluidization. The particulate material is heated in the combustion chamber (12) and then circulates through the upper passageway (18) to mix with and heat fresh feed material introduced into the pyrolysis chamber (10) giving off process vapours.



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"METHOD OF AND APPARATUS FOR CONTACTING FLUIDS  
AND PARTICULATE MATERIALS"

This invention relates to a method of and apparatus for contacting fluid and particulate material. The invention has application to a broad range of processes and it embodies the generic concept of fluidizing a particulate material in a manner such that the material is induced to circulate through two or more chambers and, in so doing, make contact with fluid or other particulate matter in the respective chambers.

The method and apparatus are particularly adapted for use in the pyrolysis of particulate material by a continuous process utilising heat medium particles. Throughout this specification where the term "continuous process" is used it is to be understood to refer to a process as distinct from a batch process and may, for example, include the intermittent feed of fresh material into the process system.

It is desirable to provide a method of and apparatus for the pyrolysis of particulate material which will enable that material to be heated in an efficient and yet simple manner without the necessity for the use of complex transfer or heating equipment.

It is therefore an object of the present invention to provide a method of and apparatus for the pyrolysis of particulate material which will go at least part of the way toward meeting the foregoing desiderata in a simple yet effective manner, or which will at least provide the

public with a useful choice.

Accordingly in one aspect the invention consists in a method for the pyrolysis of particulate material by a continuous process utilising heat medium particles. 5 characterised by the provision of two adjacent chambers being a pyrolysis chamber and a combustion chamber, each containing a fluidized bed of particulate material, wherein the heat medium particles are heated in the combustion chamber and overflow by natural circulation 10 through an upper interconnection into the pyrolysis chamber where they mix with and heat fresh particulate material fed into the pyrolysis chamber causing the particulate material to give off product vapours, the heat medium particles and particulate material then 15 passing into the combustion chamber and being re-heated and re-cycled through the upper interconnection into the pyrolysis chamber as heat medium particles, surplus particles being removed from at least one chamber to maintain a predetermined quantity of particles in the two 20 chambers.

Preferably the heat medium particles and particulate material are passed from the pyrolysis chamber to the combustion chamber through a lower return passage located adjacent the bottom of the two respective chambers.

25 Alternatively the heat medium particles and particulate material are passed from the pyrolysis chamber into the combustion chamber by a second upper interconnection at a location remote from the first said upper interconnection.

30 Preferably the surplus particles are removed from the combustion chamber.

In a further aspect the invention consists in apparatus for the pyrolysis of particulate material by a continuous process utilising heat medium particles, said 35 apparatus comprising: two adjacent chambers being a pyrolysis chamber and a combustion chamber, each being

provided with means to maintain a fluidized bed of particulate material therein. an upper interconnection between the chambers so positioned in conjunction with the configuration of the combustion chamber that

5 particles heated in the combustion chamber overflow through the upper interconnection into the pyrolysis chamber. feed means arranged to feed controlled amounts of fresh particulate material into the pyrolysis chamber, a return passage from the pyrolysis chamber to the

10 combustion chamber shaped and positioned for circulation of particles between the chambers through the upper interconnection and the return passage, and removal means arranged to remove surplus particles from at least one chamber to maintain a predetermined quantity of particles

15 in the two chambers.

Preferably said return passage is located in the lower part of the two chambers.

Alternatively the return passage comprises a second upper interconnection at a location remote from the first

20 said upper interconnection.

Preferably said removal means is located in the combustion chamber.

Preferably the pyrolysis chamber is shaped with at least one upwardly inwardly converging side wall causing

25 an upward acceleration of the fluidized particulate material therein toward the first upper interconnection.

Preferably the side wall of the pyrolysis chamber below the first upper interconnection is provided with an inwardly upwardly sloping wall arranged to promote the

30 upward movement of particulate material and entrain gas bubbles causing particulate material entering the pyrolysis chamber through the first upper interconnection to be entrained in an upward movement for circulation and mixing within the pyrolysis chamber.

35 Notwithstanding any other forms that may fall within its scope, one preferred form of the invention and

variations thereof will now be described by way of example only with reference to the accompanying drawings in which:-

5 Fig. 1 is a diagrammatic cross-sectional elevation of apparatus for the pyrolysis of particulate material according to the invention;

Fig. 2 is a diagrammatic cross-sectional elevation of a third alternative form of apparatus providing for separate flow paths of gas and/or vapour entering and  
10 exiting from the apparatus;

Fig. 3 is an enlarged cross-sectional elevation of the passages between the chambers of the apparatus shown in Fig. 2;

15 Fig. 4 is a schematic plan view of an alternative layout of the two chambers;

Fig. 5 is a schematic plan view of an alternative configuration providing for plug flow; and

Fig. 6 is a schematic plan view of a still further alternative configuration.

20 The invention will firstly be described with reference to Fig. 1 in which a simple form of retorting device is described in which the invention may be put into effect.

25 As shown in Figure 1, the retorting device comprises a pyrolysis chamber in the form of an outer cylindrical chamber 10, which is defined by a wall 11, and an inner combustion chamber 12. The inner chamber 12 is defined by a wall 13 which has a generally frusto-conical form.

30 The two chambers 10 and 12 are located above a base 14 which incorporates a central apertured or grid-type plate 15 through which air is passed in use of the retort. Air is directed into the chambers 10 and 12, by way of the plate 15, from a lower chamber 16 which is connected to a source of pressurised air by a pipe 17.

35 Upper and lower passages 18 and 19 connect the two chambers 10 and 12, such passages permitting free flow of

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material between the chambers in the direction indicated by the heavy arrows.

5 The upper region 25 of the central combustion chamber 12 is encircled by a cylindrical wall 26, and a duct 27 which communicates with the upper chamber region 25 is employed for extracting waste gases of the combustion which occurs within the central chamber 12.

10 The wall 26 also forms an inner wall of an annular chamber 29 which is located above the outer pyrolysis chamber 10 and two outlet ducts 30 are provided for conveying from the retort product vapours and gases which are released as a result of heat exchange between fresh feed material and recirculated heat medium material in the outer chamber 10.

15 Additionally, a product return line 31 may be provided for directing a proportion of the product gas and vapour back into the outer chamber 10, for use as a fluidizing medium and/or for product improvement. An inlet passage 22 enters the chamber 10 through wall 11.  
20 The inlet passage 22 provides for admission of feed material to the outer chamber 10 of the retort.

An outlet conduit 23 is provided adjacent the bottom of the outer chamber 10 for bleeding spent feed material from the retort.

25 In operation of the retort, fresh feed material such as coal or oil shale in particulate form is admitted to the outer chamber 10 by way of the inlet passages 22 and is contacted with heat medium material which has previously been passed through and heated in the inner  
30 chamber 12. During the time that the material is resident in the outer chamber 10 it is maintained in a fluidized state by air which is admitted to the chamber by way of the grid 15 and/or by gaseous and vapour products which are released by the feed material as a  
35 result of heat exchange between the heat medium material and the feed material.

Whilst in the fluidized state, the feed material in the outer chamber 10 migrates toward the bottom of the chamber and then passes through the passageway 19 to enter the inner chamber 12. Having entered the inner chamber, the material is subjected to further fluidization by the air which enters through the grid 15 and the fluidized particles are subjected to an upward accelerating force. The upward accelerating force is produced as a result of the geometrical form of the wall 13, which causes the air and entrained particles to increase in velocity with increased height of movement through the chamber 12.

Having passed through the outer pyrolysis chamber 10 and having been stripped of product vapours and gases as a result of heat gained from the heat medium material, the particles will enter the inner chamber 12 in a heated condition and with residual surface carbon on the particles. This residual carbon is combusted in the inner combustion chamber 12 when exposed to the combustion supporting air which is admitted through the grid 15 and will be heated to a higher level during passage thereof through the inner chamber.

Having moved upwardly through the inner chamber 12, the heated particles then flow through the upper passageway 18 to enter the outer chamber 10 as heat medium material for further heat exchange contact with fresh feed material which enters the outer chamber through the inlet passages 22.

The cycle is repeated with continuous circulation of the material through and between the two chambers 10 and 12. As abovementioned, the circulation is induced by the profiling of the wall 13 and/or the position of the upper interconnecting passage 18 and no mechanical aid to circulation is employed.

Spent feed material is progressively bled from the lower region of the outer chamber by way of removal means

in the form of outlet conduit 23. The rate of bleeding of the spent material is balanced with the infeed of fresh feed material, so as to maintain a constant volume of material within the retort and so as to maintain optimum recovery of product vapours and gases from the material in the outer chamber 10.

The upwardly mobile product gases and vapours from the outer chamber 10 are collected in and carried from the retort by way of the ducts 29, 30 and the waste gases of combustion in the inner chamber 12 pass out through the duct 27.

Start-up of the retort is effected by flame heating the material within the retort until the required operating condition are reached. The operating temperatures might typically be  $550^{\circ}\text{C}$  in the outer chamber 10 and  $900^{\circ}\text{C}$  in the inner chamber 12.

The retort device which is illustrated in Figure 2 of the drawings comprises a housing 32 which is mounted above two partitioned cavities 34 and 35. The housing 32 has a generally rectangular cross-section, as viewed in plan, and a mesh-type grid 36 is interposed between the cavities and the housing.

The housing is divided into first and second chambers 37 and 38, which may be referred to respectively as combustion and pyrolysis chambers, and the first chamber is configured such that its cross-sectional area decreases over approximately two-thirds of the height of the chamber. Thus, the first chamber 37 is defined by one wall 39 which inclines inwardly and upwardly and which intersects a downwardly inclined ledge 40 forming a throat 42 in the combustion chamber.

The two chambers 37 and 38 are separated by a partition wall, 41, 43 in which is provided an upper interconnection 44 and a lower interconnection 46. The upper interconnection comprises an opening between the lower part 41 of the partition wall and the upper part 43



and is located in the region of the throat 42. The upper interconnection 44 extends through the wall and then downwardly in a parallel sided portion formed by a baffle 43A. In this manner a passageway is formed extending  
5 between the upper reaches of the combustion chamber 37 and the pyrolysis chamber 38.

The dividing wall 41 terminates short of the base 45 of the housing and defines a second passageway 46 which permits communication between the lower reaches of the  
10 first and second chambers.

Two exhaust ducts 47 and 48 are located above the first and second chambers 37 and 38, and a feed material inlet 49 extends into a side wall 50 of the housing. Additionally, an outlet 51 for spent feed material is  
15 located in the combustion chamber, preferably toward the upper edge of the ledge 40.

In operation of the apparatus shown in Figure 2, feed material in particulate form is loaded into the two chambers and, ignoring start-up conditions, residual  
20 carbon in the material in the first chamber 37 is combusted by exposing the (already hot) material to combustion supporting air. The air is delivered to the first chamber 37 by way of the cavity 34 and at a pressure sufficient to fluidize the particles in the  
25 first chamber. Fluidization is maintained at a level sufficient to sustain the particles in a fluidized state, but the pressure of the admitted air is not so great as to cause entrainment and exhausting of significant quantities of the particles.

30 Due to the profiling of the first chamber 37 and the consequential existence of upwardly accelerating fluid forces, the fluidized particles within the first chamber are moved progressively upwardly through the chamber and they then spill over the lip of the wall 41 to enter the  
35 second chamber 38 by way of the first passageway 44. On entering the second chamber 38, the particles have a high

temperature, resulting from retained heat of combustion of the residual carbon of the particles. Thus, the particles may be referred to as "heat medium particles".

5 Gaseous products of the combustion process are exhausted through the duct 47 and, being upwardly mobile, tend not to enter the second chamber 38 with the heat medium particles.

10 On entering the second chamber 38, the heat medium particles react with fresh feed material, which is admitted to the second chamber 38 by the feed inlet 49, and the consequential heat exchange between the particles causes gas and vapour products to be released from the feed material at all levels throughout the chamber 38. The released gas and vapour products tend to induce  
15 fluidization of the heat medium and feed particles within the second chamber 38 but, if the fluidizing effect of such products is insufficient to cause a required level of fluidization, a supplementary fluidizing medium may be admitted to the chamber 38 by way of the cavity 35.

20 The gas and vapour products which are released in the reaction bed within the chamber 38 are exhausted through the duct 48 and, if required, a portion of the exhausted gas and vapour products may be fed back into the second chamber 38, by way of the cavity 35, to act as  
25 the fluidizing medium.

The particles within the second chamber 38 are induced to move progressively downwardly through the chamber, as a consequence of the upward movement of the particles in the first chamber 37 and the particles are  
30 thereby induced to pass through the passageway 46 to enter the first chamber 37.

Thus, as in the previously described embodiments of the invention, the fresh feed material and the heat medium material is circulated through the retort without  
35 the assistance of any mechanical contrivances.

A proportion of the spent material which passes into

the combustion chamber 37 is removed from that chamber by way of the outlet 51, so that the total volume of material within the two chambers 37 and 38 remains substantially constant with addition of the fresh feed material.

5 The pyrolysis chamber side of the lower dividing wall 41 is also profiled to a particular configuration as may be most clearly seen in Figure 3. The lower edge of the wall 41 is brought to a wedge-like configuration immediately above the passageway 46 and is provided with an upwardly inwardly inclined surface 41B protruding into the pyrolysis chamber. This surface is terminated by an upwardly outwardly inclined shelf 41A located below the outlet from the passageway 44. This configuration has the advantage that bubbles 52 from the gas inlet grille 36 or from the pyrolysis reaction form on the sloping surface 41B and enlarge as shown at 53 while travelling upwardly along the surface. The bubbles break away from the surface at the intersection point 54 creating a highly aerated zone at the exit from the passageway 44. Solids emerging from the passageway 44 are drawn into the wake of the bubbles in an outward direction giving rise to overall circulation in the fluidized bed. This configuration helps to prevent the solids "short circuiting", i.e. proceeding directly from the outlet from the passageway 44 to the lower interconnection 46.

It is a further feature of the lower wall configuration that the sharp tip 55 allows the use of a small non-aerated zone 36A in the gas inlet grille 36. The small non-aerated zone means that a low clearance can be used between the tip 55 and the grille 36, helping to prevent the undesired passage of gases from one chamber to the other. Should it be found that gas mixing from one chamber to the other is a problem then it is possible to inject an inert gas such as steam into the locality of the passageway 46 (and in some cases even into the upper

connecting passage 44) to block the gas transfer.

It is also desirable that the upper interconnecting passageway 44 is provided through a downwardly facing chute 56 to ensure low gas leakage. The chute preferably has parallel or diverging sides so that solids will not become jammed and the chute can therefore be narrowed to inhibit gas leakage.

Although the invention has been described thusfar in the context of retorting devices, it is to be understood that the invention does have other applications. Some of these envisaged applications are as follows.

- (a) Oil shale retorting.
- (b) Gasification of solid fuels, particularly very high ash material.
- (c) Hydrogen generation - particularly from high ash material such as spent shale, washery waste.
- (d) Waste heat recovery from very dirty gas streams. The gas gives its heat to a solid which is transferred to another chamber where it is used to preheat another gas stream.
- (e) Filtration: The solids in a dirty flue gas are trapped in one chamber, and blown off in the other.
- (f) Flue gas cleaning.  $\text{SO}_2$  is absorbed in one chamber and desorbed in another for recovery.
- (g) Recovery of sulphur from pyrites ( $\text{FeS}_2$ ). The  $\text{FeS}_2$  is heated in one chamber to give  $\text{FeS} + \text{S}$  and burnt in the other chamber to give  $\text{SO}_2 +$  heat. Half the sulphur is recovered as sulphur rather than as  $\text{SO}_2$ .

Hydrogen generation may be effected in a device of the type shown in Figure 2, by admitting particulate coal to the second chamber 38 by way of the feed inlet 49 and by subjecting the coal particles to a fluidizing medium in the form of steam. The steam is admitted to the chamber 38 by way of the lower chamber 35 and the

fluidized feed material is contacted with a suitable heat medium material recirculating between the chambers and which has previously been subjected to combustion in the first chamber 37. After reacting the feed and heat medium particles in the presence of steam in the second chamber 38, the particles flow into the first chamber 37 where residual carbon is combusted in the presence of air which is admitted to the chamber 37 by way of the lower chamber 34. This method is particularly suitable for use with high ash coals or spent oil shale.

Products of the combustion, including carbon dioxide and nitrogen, are exhausted through the outlet duct 48. Products of the heat exchange reaction within the second chamber 38, including carbon monoxide, hydrogen and volatile products of coal are exhausted through the outlet duct 47. Gaseous and vapour products additional to hydrogen may be collected for subsequent use.

In certain of the processes in which the apparatus may be employed, such as in gas separation and ion exchange processes, no heating would normally be effected and, thus, it should be understood that the devices illustrated in the drawings need not in all applications be employed as retorts. Also, in certain applications to which the devices may be put, such as in ion exchange processes, the fluids which are directed into the chambers may comprise liquids.

Although the invention has been described thusfar with reference to transfer between the combustion and pyrolysis chambers as taking place through an upper interconnection from the combustion chamber to the pyrolysis chamber and a lower interconnection in the opposite direction, it is also possible to achieve circulation by transfer through two upper interconnections (i.e. by two "overflow" transfers rather than by an "overflow" and "underflow" combination) in which at one end of a rectangular bed solids are thrown

from left to right and at the other end solids are thrown from right to left as shown diagrammatically in Figure 4. In this situation solids are overthrown at 60 from the combustion chamber 61 to the pyrolysis chamber 62 adjacent one end 63 and are returned, also by overflow 64 adjacent the other end 65.

Simplified theory of fluidized beds often assumes that the beds are "perfectly mixed". Hence a small cluster of particles entering the bed will immediately be dispersed. This is one extreme theoretical model. Another is so-called "plug flow" in which the cluster of solids maintains its identity as it flows through the bed in the shortest possible journey. Sometimes "perfect mixing" is desirable, sometimes plug flow, and sometimes a hybrid. In any event it is always desirable to be able to "dial in" whatever level of mixing is required.

In the first version of the invention, solids leave one chamber via the top of the bed ("overflow") and re-enter at the bottom ("underflow"), and both chambers approximate perfect mixing.

The "double overflow" system as shown basically in Figure 5 opens up the possibility of achieving something approaching plug flow in the system using a series of baffles as shown in Figure 5. In this situation the configuration of the chambers is basically as shown in Figure 4 with the addition of staggered baffles 66. This forms a tortuous path in each chamber inducing plug flow between the baffles as shown by the single arrows in Figure 5. The more baffles that are provided the closer is the approximation to plug flow. Although the configuration shown in Figure 5 incorporates "double overflow" it will be appreciated that the return flow 67 could equally be an underflow return of the type shown in Figures 1 to 3.

A further configuration using "multiple overflow" between baffle chambers is shown diagrammatically in

Figure 6 having a similar configuration to that of Figure 5 but incorporating multiple overflow interconnections 68. The return flow could be by way of "underflow" 69. This configuration is particularly applicable to oil shale retorting in which the raw feed shale is fed into the pyrolysis chamber 62 at 70 and the spent shale is withdrawn from the combustion chamber 61 at 71. The baffles divide the system into five chambers A, B, C, D and E. In chambers A, B, C, and D we have overflow left to right as shown in Figure 6 and in chamber E we have return underflow right to left. The individual chambers can be designed to achieve different circulation rates in each chamber; the baffles ensure that the solids are no longer perfectly mixed but approach plug flow.

In practice this means that any temperature profile can be achieved in the retort to optimize the yield. Thus chamber A might be run at a relatively low temperature to protect sensitive species; and the temperatures could be increased in the chambers B, C, D to drive off all the product. Thus we have the high yields associated with high temperature, and the benefits of a gradual and controlled temperature increase.

There is an additional advantage that the approach to plug flow achieves: The shale entering the system would not be able to pass quickly through the retort (no by-passing) and this means the losses associated with by-passing would be reduced.

Similarly in the combustion chamber, the losses of carbon fuel on the spent shale would be reduced because spent shale could not by-pass the system.

Hence this system would seem to offer prospects of very high yields and very high recovery of the energy values on the spent shale.

CLAIMS

1. A method for the pyrolysis of particulate material by a continuous process utilising heat medium particles in two chambers being a pyrolysis chamber and a combustion chamber, each containing a fluidized bed of particulate material, wherein the heat medium particles are heated in the combustion chamber and are passed into the pyrolysis chamber, heating the particulate material and causing the particulate material to give off product vapours, characterised by the location of the two chambers side-by-side connected by an upper interconnection and a return passage, wherein the heat medium particles overflow by natural circulation through the upper interconnection into the pyrolysis chamber where they mix with and heat fresh particulate material the heat medium particles and particulate material then passing into the combustion chamber and being re-heated and re-cycled through the upper interconnection into the pyrolysis chamber as heat medium particles, surplus particles being removed from at least one chamber to maintain a predetermined quantity of particles in the two chambers.

2. A method as claimed in claim 1, wherein the heat medium particles and particulate material pass from the pyrolysis chamber to the combustion chamber through a lower return passage located adjacent the bottom of the two respective chambers.

3. A method as claimed in claim 1, wherein the surplus particles are removed from the combustion chamber.

4. A method as claimed in claim 1, wherein the overflow of heat medium particles through the upper interconnection is induced by the configuration of the combustion chamber.

5. A method as claimed in claim 1, wherein the heat medium particles and particulate material are passed from the pyrolysis chamber into the combustion chamber by



a second upper inter connection.

6. A method as claimed in claim 5, wherein the flow of particles in the pyrolysis chamber between the first upper interconnection and the second upper  
5 interconnection is controlled to approximate a plug flow situation.

7. A method as claimed in claim 6, wherein a plug flow situation is also induced in the combustion chamber from the second upper interconnection to the first upper  
10 interconnection.

8. A method as claimed in claim 1, wherein a movement approximating a plug flow is induced in the pyrolysis chamber and wherein a plurality of upper interconnections from the combustion chamber to the  
15 pyrolysis chamber are provided causing heat medium particles to be introduced to the particulate material in the pyrolysis chamber at various stages in the plug flow.

9. A method as claimed in claim 8, wherein plug flow is also induced in the combustion chamber causing  
20 heat medium particles to be transferred to the pyrolysis chamber from various selected phases of the plug flow in the combustion chamber.

10. Apparatus for the pyrolysis of particulate material by a continuous process utilising heat medium  
25 particles, said apparatus comprising two chambers being a pyrolysis chamber and a combustion chamber, each being provided with means to maintain a fluidized bed of particulate material therein, characterised by the location of the chambers side-by-side with an upper  
30 interconnection between the chambers so positioned in conjunction with the configuration of the combustion chamber that particles heated in the combustion chamber overflow through the upper interconnection into the pyrolysis chamber, feed means arranged to feed controlled  
35 amounts of fresh particulate material into the pyrolysis chamber, a return passage from the pyrolysis chamber to

the combustion chamber shaped and positioned for circulation of particles between the chambers through the upper interconnection and the return passage, and removal means arranged to remove surplus particles from at least one chamber to maintain a predetermined quantity of particles in the two chambers.

11. Apparatus as claimed in claim 10, wherein the return passage is located in the lower part of the two chambers.

12. Apparatus as claimed in claim 10, wherein the removal means is located in the combustion chamber.

13. Apparatus as claimed in claim 10, wherein the combustion chamber is shaped with at least one upwardly inwardly converging side wall causing an upward acceleration of the fluidized particulate material therein toward the first upper interconnection.

14. Apparatus as claimed in claim 10, wherein the side wall of the pyrolysis chamber below the first upper interconnection is provided with an inwardly upwardly sloping wall arranged to promote the upward movement of particulate material and entrain gas bubbles causing particulate material entering the pyrolysis chamber through the first upper interconnection to be entrained in an upward movement for circulation and mixing within the pyrolysis chamber.

15. Apparatus as claimed in claim 10, wherein the upper interconnection incorporates a downwardly facing chute.

16. Apparatus as claimed in claim 10, wherein the return passage comprises a second upper interconnection at a location remote from the first upper interconnection.

17. Apparatus as claimed in claim 16, wherein a plurality of baffles are provided in the pyrolysis chamber between the first upper interconnection and the second upper interconnection, arranged to induce an approximate plug flow situation in the pyrolysis chamber.

18. Apparatus as claimed in claim 10, wherein a plurality of baffles are provided in the pyrolysis chamber, dividing that chamber into a plurality of sub-chambers, and inducing an approximate plug flow situation from one sub-chamber to the next, wherein a plurality of upper interconnections are provided from the combustion chamber into respective said sub-chambers allowing heat medium particles to be introduced to the particulate material in the pyrolysis chamber at various stages in the plug flow therein.

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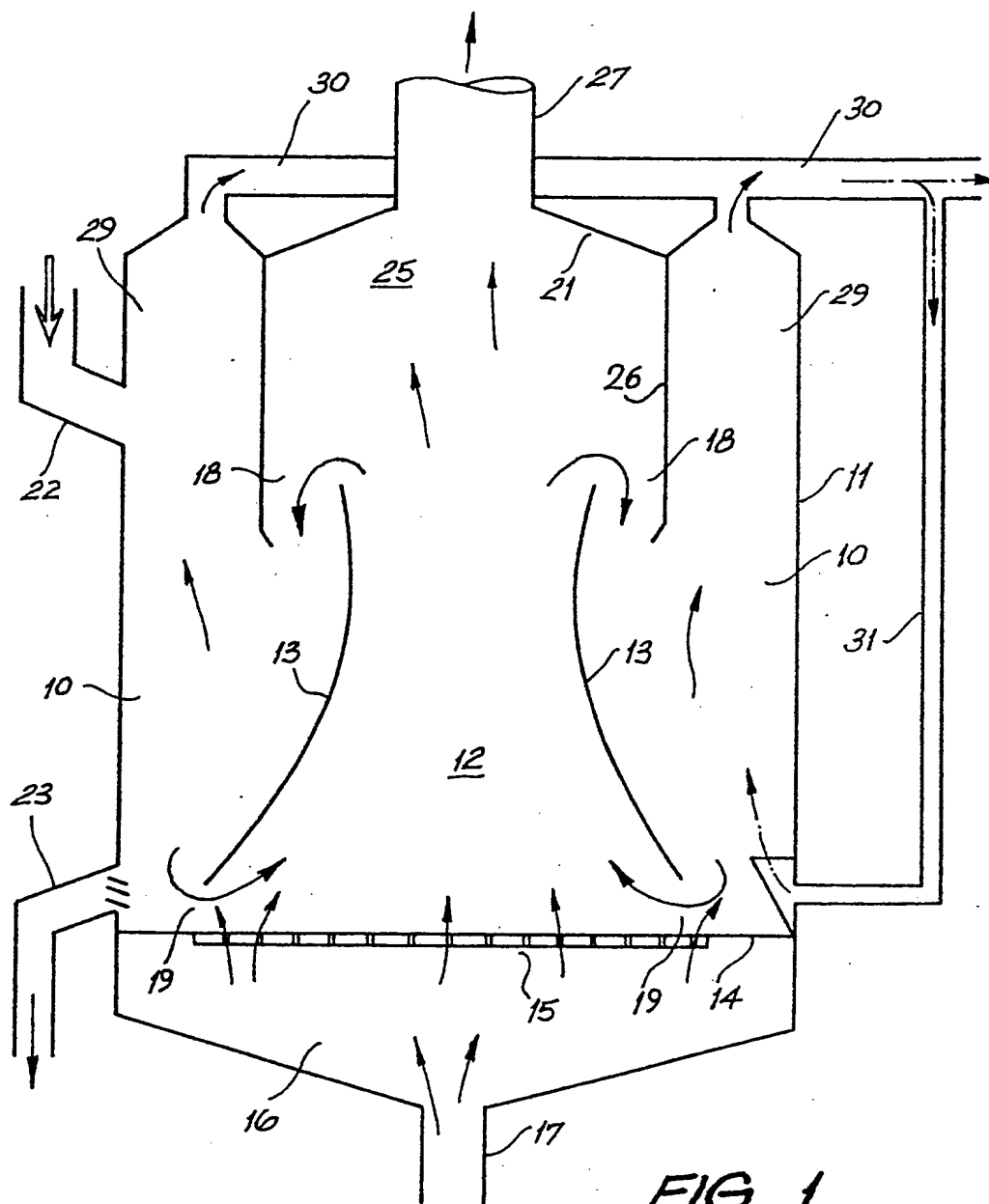


FIG. 1

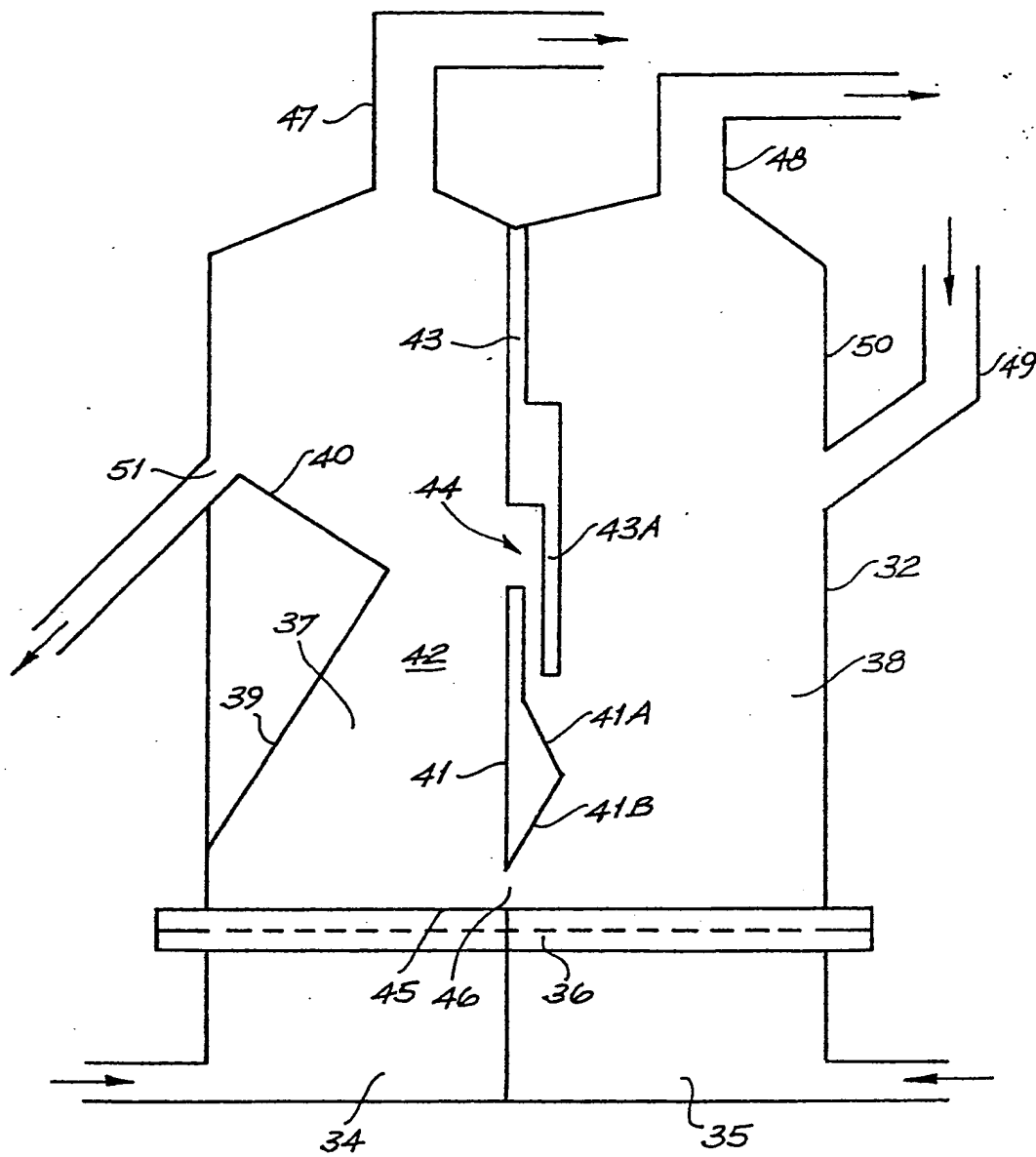
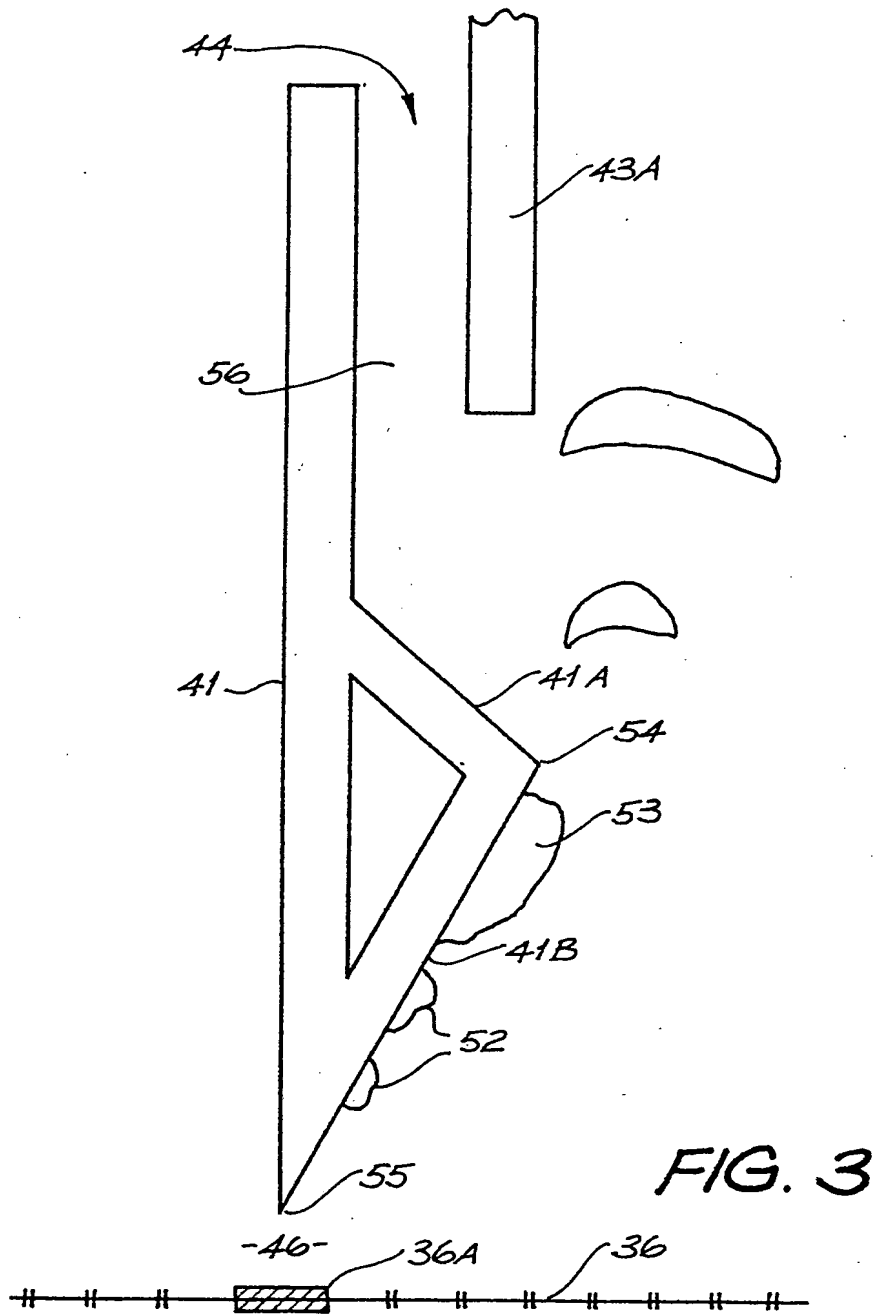


FIG. 2

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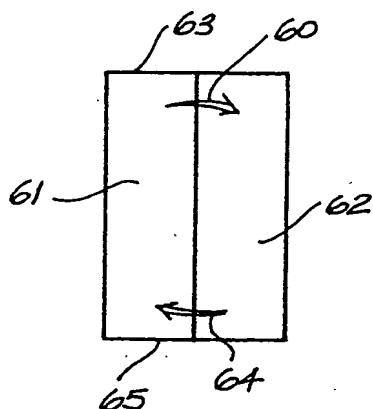


FIG. 4

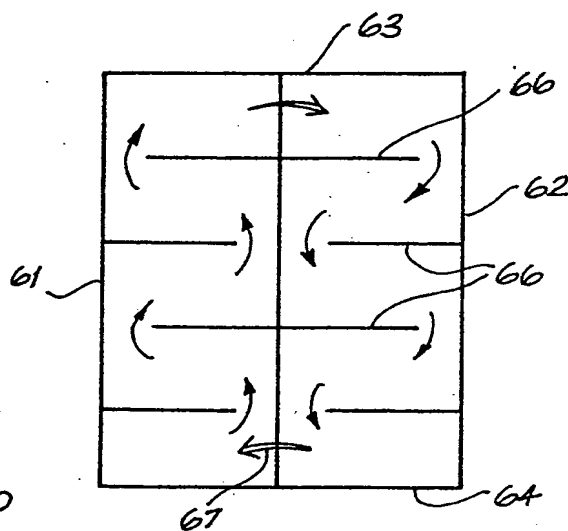


FIG. 5

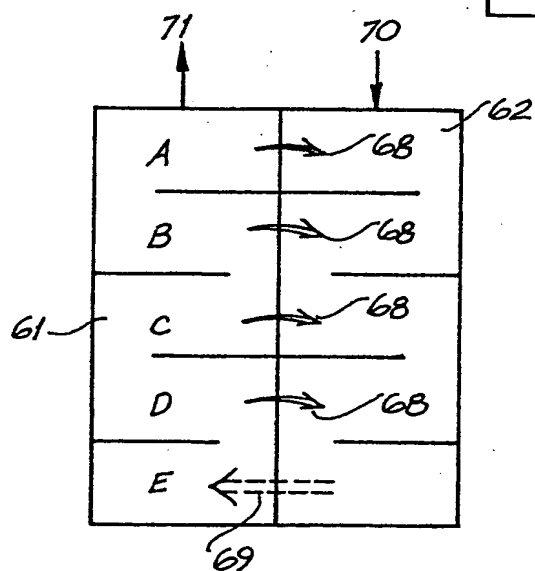


FIG. 6



European Patent  
Office

# EUROPEAN SEARCH REPORT

0117634  
Application number

DOCUMENTS CONSIDERED TO BE RELEVANT			EP 84300493.8
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 7)
A	GB - A - 672 080 (STANDARD OIL DEVELOPMENT COMPANY) * Claims; page 2, lines 19-71 *	1	C 10 G 1/02 C 10 G 9/28 B 01 J 8/26
A	US - A - 3 346 481 (C.I. JOHNSEN) * Claims; column 1, line 27 - column 2, line 10 *	1,10	
A	US - A - 3 297 562 (R.E. BIDDICK et al.) * Claims; column 1, line 21 - column 6, line 44 *	1,2,10	
A	US - A - 3 708 552 (KUNII et al.) * Claims; column 1, line 21 - column 3, line 57 *	10,11	
A	GB - A - 2 063 702 (EXXON RESEARCH AND ENGINEERING COMPANY) * Claims; page 1, line 9 - page 2, line 37 *	1,10	C 01 G 1/00 B 01 J
A	US - A - 3 546 092 (R.W. WHITEACRE BRD) * Claims; column 1, line 25 - column 2, line 14 *	1,10	
The present search report has been drawn up for all claims			
Place of search VIENNA		Date of completion of the search 04-05-1984	Examiner STÖCKLMAYER
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			